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A PERIODICAL SURVEY OF NEW
DEVELOPMENTS IN THE CONTROL
OF PESTS, DISEASES AND WEEDS



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CONTENTS

	<i>Page</i>
EDITORIAL	4
CHEMICAL CONTROL OF WHITE GRUBS OR COCKCHAFER LARVAE	
—by P. F. Aerts and M. Bougard	5
APPLICATION OF 'PERENOX' FOR CONTROL OF BLIGHT DISEASES OF POTATO IN WEST BENGAL, INDIA	
—by S. B. Chattopadhyay	12
RECENT ADVANCES IN SUGAR-CANE CULTURE IN QUEENSLAND	
—by L. G. Vallance	17
THE THREAT TO WEST AFRICAN COCOA	23
TECHNICAL BREVITIES	28

Fig. 1. *Life-cycle and Metamorphosis of the Cockchafer Beetle.*

Fig. 2. *White grubs attacking roots of apple trees. (Photo : I.C.I. (Export) Ltd., Lebanon & Syria).*

Fig. 3. *Potato plot sprayed with 'Perenox'.*

Fig. 4. *Potato plot unsprayed.*

Fig. 5. *Devastation caused by early blight of potatoes in India.*

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EDITORIAL

THE International Conference, Some Crop Protection Problems in World Agriculture, organised by Plant Protection Ltd. and attended by leading authorities in agricultural science in Great Britain and overseas countries, took place at Fernhurst from June 25th to 28th inclusive. A special report on the Conference will be issued, and a brief account of the proceedings and recommendations will appear in the next number of the *Overseas Review*.

The problems discussed in this number of the *Review* concern insect pests, fungus diseases and viruses affecting crops in Europe, Australia, India and West Africa, including control measures which have been successfully applied and possible future developments in this sphere of activity. This last consideration applies especially to the cacao viruses of West Africa, the control of which still depends on the laborious and unpopular method of felling trees showing disease symptoms. Investigations in progress in the research organisations of the chemical industry, and in other research institutes, are directed towards the discovery of practicable control measures involving the destruction by chemical means of the insect vectors of the viruses, and of trees which are alternate hosts of the viruses and their vectors.

CHEMICAL CONTROL OF WHITE GRUBS OR COCKCHAFER LARVAE

ANOTHER VICTORY FOR BHC

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INTRODUCTION

THE rapid development of crop protection science and the advent of so many, and varied, new chemical products have helped to reduce many of the most dangerous parasites of our crops. However, it would appear that the cockchafer problem and what follows naturally from it, the control of white grubs, are of such a nature that progress has been slow. In fact, for more than 25 years, leading research workers have persisted in the attack against this beetle and its larva and what results have they obtained? The possible destruction of the adult chafer and the principle by which white grubs can be controlled. Often the biology of the parasite is insufficiently known to guide the investigations. It then becomes necessary to increase our knowledge of the life history, in order to determine the most vulnerable part of the life cycle.

THE COCKCHAFER PROBLEM

We have two principal reasons to fear cockchafer, (1) as a result of the damage caused by the adults to the foliage of fruit trees and many forest trees and (2) through the ravages caused by the larvae or white grubs to the roots of many plants such as sugar beet, cereals, potatoes, and in plant nurseries, orchards and pastures.

BIOLOGY OF THE INSECTS

Much has already been written on the life cycle of the cockchafer and its larva. It would seem, however, useful to repeat here some of the more important features without going into too great detail.

THE ADULT

This is too well known to need entering into any description of its morphology. We will simply confine ourselves to studying its place in relation to the life cycle of the larva. The influence of climate and soil play a very important part here. The adult insect flies in May, its movements and the degree of damage caused being considerably

influenced by the temperature and humidity of the atmosphere. In this connection, light intensity plays an important part. Full sunshine and also complete darkness cause the adult to become immobile. It is this fact which explains the great activity of the insect in the evening or at twilight, and it is then that it launches its attack on forests and orchards causing the greatest damage around the outside of plantations. Mating takes place in the air and is almost immediately followed by egg laying, the eggs being placed 10—20 centimetres apart in soft, dry soil in groups of 30. After a second egg laying of similar numbers, the females die. The males are shorter lived but have already given rise to considerable foliage damage, benefiting from the lush August growth of oaks, beeches, pears, etc., which can usually recover from the defoliation although they often suffer a check in development. These facts have enabled us to determine three main lines of attack for the control of the adult.

1. Gathering by hand and, more recently, chemical destruction in orchards and forests with the aid of DDT or BHC as a dust or liquid spray.
2. Destruction of eggs by exposing them to air and sunlight as the result of cultural operations, hoeing, etc. . . .
3. Autumn destruction of first year larvae during ploughing. Mention should be made here of the vast control operations carried out at Etrepagny, France, during 1949, when an area of nearly 40,000 hectares was treated by aerial application for the control of the adult insect. In our opinion, the control of the adult does not provide the solution to the problem, for many of the insects are able to find shelter in inaccessible places and avoid destruction.

WHITE GRUBS

Approximately 4 weeks after egg laying the larvae hatch and their subsequent development takes approximately 3 years. From the moment of hatching the young larvae feed on the fine roots and root hairs in their immediate vicinity, but this damage is of little importance. At the end of the first summer they reach a length of 20 mm. and descend to a depth of 40—50 cm. in the soil, where they remain until the following spring. Rising to the surface again, they feed voraciously on the roots of all kinds of cultivated plants. In the autumn of the second year the white grubs hibernate at a greater depth and the larval life cycle is completed by spring of the third year, when they reach the most resistant stage. Having reached a maximum size of 4—5 cm. in length and 1 cm. in diameter, the larvae loose their severe feeding habits, and in June to July, they descend to a depth of 50 cm. to 1 mtr., according to the type of soil, and change to pupae. In September of the same year the adults emerge from the pupae but remain in the ground until May of the following year, although if the weather is particularly mild, some may emerge in October of the

third year. Some larvae will extend their life cycle by another year, but these are exceptions. In order to illustrate our remarks, we have prepared the accompanying chart (Fig. 1). Examination of this chart shows very clearly that the larvae, by descending so deeply in the soil during winter, render control measures particularly difficult.

CONTROL MEASURES AGAINST WHITE GRUBS

The control measures are designed according to the age of the larvae. Fortunately, the triennial periodicity of the adult flight in any particular locality enable us to forecast the stage of development of the larvae before deciding on the method of treatment. The method of treatment will, in turn, depend upon the type of culture, texture of soil, time of year and the products available which are likely to give the best control. We must distinguish between preventive and curative methods. Of the first, we would mention, once again, those previously mentioned, notably, collection of the adults and destruction of eggs and young larvae by cultural methods. However, in wet seasons, these methods of treatment are unsatisfactory and can give indefinite results in fruit and ornamental plantations. Only curative treatments through the application of chemicals based on the accurate knowledge of the stage of development of the larvae and local characteristics are likely to provide a complete answer to the problem.

How is the presence of larvae or the state of their development determined?

The method is simple and practical. It consists essentially of sampling at 20—25 metre intervals, taking out a sample one metre in length by a spade's width (20 cm.). The number of larvae per square metre is obtained by multiplying by five the total number of larvae obtained in a certain number of samples and dividing the result by this latter figure. This operation can be effectively carried out at the end of August and September, which is the only time when all the larval stages are to be found not deeper than 30 cm. If the average number resulting from the sampling is more than three larvae per square metre, an attack the following spring can be assumed and control measures should be applied. It is not uncommon to find larval populations varying from 50—100 individuals per square metre.

THE CHEMICAL METHODS OF CONTROL

The systematic examination of many modern insecticides has very rapidly shown that only benzene hexachloride (BHC or 666) will give sufficient effect on the larvae to prevent attack on vegetation. However, it is with carbon bisulphide, alone or in combination with paradichlorobenzene, that the best results have been obtained in the past. Special attention, however, must be drawn to the high phytotoxicity of this product, which can only be used on soil which will remain uncropped for a period of at least three months. Liquid application of DDT Emulsion proved practical, but with an uncertain success, until the arrival of BHC.

THE USE OF BENZENE HEXACHLORIDE

For the last three years we have intensified our experiments in the use of this product and we give below a brief account of the results obtained. Our investigations have been carried out both in sugar beet as well as in pastures, plant nurseries and orchards. The choice of the type of BHC products to use or their method of application has been determined by the particular crop to be treated.

CURATIVE TREATMENT — BEFORE SOWING OR PLANTING

We advise the application of 25 kg. of 'Cloxane' 40, which is equivalent to 1.5 kilos of gamma-isomer per hectare; this dose to be worked into the soil by harrowing.

IN CULTIVATED GROUND

'Cloxane' 40 has not proved effective, possibly owing to the fact that it is impossible to bring about a sufficient contact between the product and the larvae. However, wet application or injection by Pal Injector is to be recommended using 'Agroicide' Dispersible Powder at doses depending on the crop to be treated. The following are some typical cases :—

(a) Agricultural crops (sugar beet, cereals, etc.) plant nurseries, fruit plantations and pastures.

Mix 25 kg. of 'Cloxane' 40 (1.5 kg. of gamma isomer) either with the artificial manure to be applied or with five times its weight of sand. The mixture should be uniformly broadcast over the soil and harrowed in to a depth of 15—25 cm. When planting fruit trees, where cultivation is confined only to the planting hole, it is recommended to use 'Cloxane' 40 at the rate of 10 grams per cubic metre of soil removed from the hole.

(b) Treatment of permanent pastures : In this case, the penetration of insecticides is rendered difficult by the close matt of roots and old grass which may occur. It is, however, most important that the chemical should come in contact with the larvae. The best method of treatment, therefore, consists in the application of 35 kg. of 'Agroicide' Dispersible Powder per hectare (equivalent to 2.5 kg. of gamma-isomer) applied in 8,000 to 10,000 litres of water. The quantity of water varies according to the depth at which the larvae are found in the soil as well as to the soil texture and the season of application. The quantity of water, however, should never be less than 8,000 litres per hectare. Drainage from manure pits, which are often used in certain parts of the country, can replace water. Application should be preferably carried out during or immediately following periods of rain. This enhances the penetration of BHC into the grass roots. Whilst spraying may be possible in non-hilly areas, it may not be so where hills occur, in which case wet treatment can be replaced by the application of 50 kg. of 'Cloxane' 40 per

LIFE-CYCLE AND METAMORPHOSIS OF THE COCKCHAFFER BEETLE

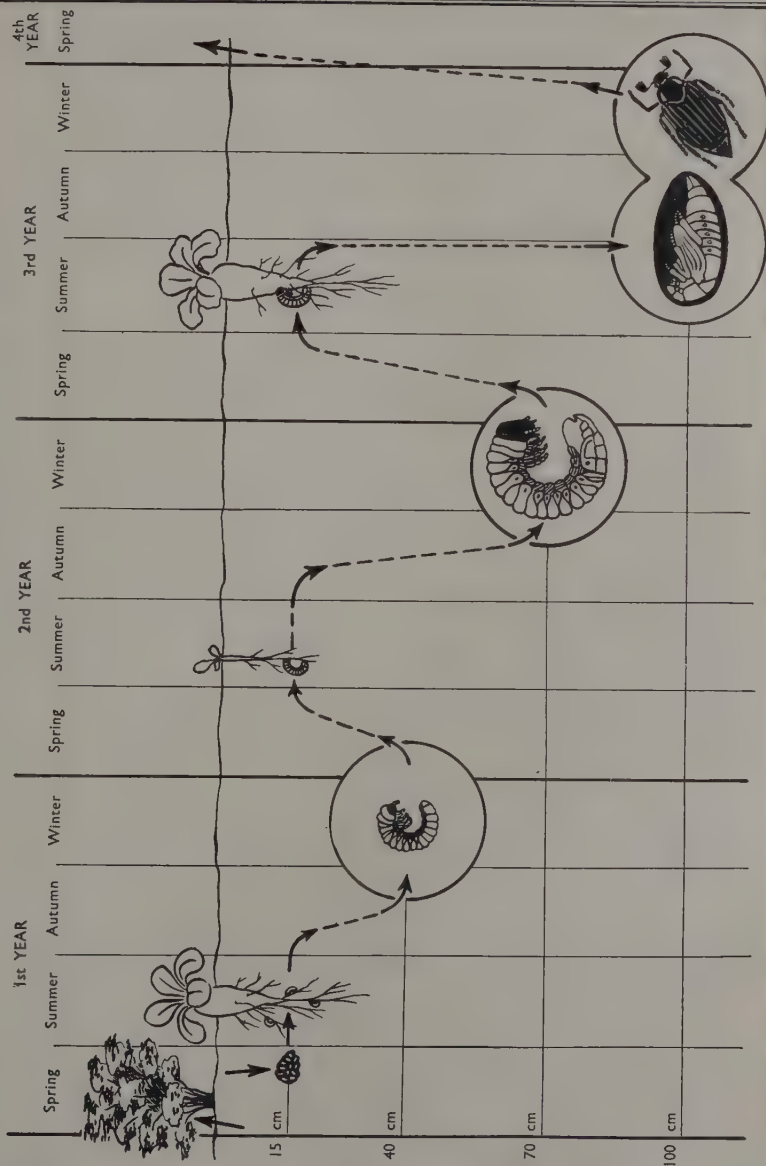


Fig. 1.



(Photo: I.C.I. (Export) Ltd., Lebanon & Syria).

Fig. 2.—White grubs attacking roots of apple trees

hectare during periods of rain in spring. After or during peak flight of chafers, preventive control can be carried out by the applications of 10—20 kg. 'Cloxane' 40 per hectare mixed with fertilizers or sand applied just prior to the flight period.

TREATMENT OF GROWING CROPS

This falls into three distinct classes :—

1. Strawberries, asparagus, flowers, etc.

As a preventive treatment in new plantations, the following treatment can be applied to soil before planting. In established crops treatment can consist of a spray application of 'Agrocide' Dispersible Powder at the rate of 500 grams in 400—500 litres of water per are. Penetration of the liquid down to the roots may be assisted by forking the ground. In the case of strawberries and asparagus, treatments should be done after cropping in order to avoid taint.

2. In nurseries of fruit trees, forest trees and ornamentals

Owing to the surface rooting nature of the young plants, watering with a solution of 'Agrocide' Dispersible Powder containing 500 grams per 100 litres of water at the rate of 400—500 litres per are is necessary. Cultivate the soil around the plants in order to assist penetration.

3. In orchards

In this case the problem is doubled, it being necessary to destroy the chafer larvae between the rows of trees as well as in the vicinity of the roots. Irrespective of whether the orchard is grassed down or not, control of larvae between the rows can be carried out according to directions already given. For treatment amongst the roots of the trees, it is necessary to use pressure injection of 3—7 litres of 'Agrocide' Dispersible Powder solution per tree, the amount depending on the root development. Injection is carried out either with a Pal Injector or with an ordinary injector or spraylance with pressure provided by the spraying machine. The liquid for injection contains one kilo of 'Agrocide' Dispersible Powder per 500 litres of water. If the spring growth is suffering from defoliation by the adults, a liquid fertilizer may be added to the insecticide.

N.B. : The above treatments will control, in the one operation, wireworm and other soil insects. In the case of application in commercial plantations, consideration must be given to the crop rotation, as ground treated with BHC is likely to cause taint in certain crops during two years after treatment.

CONSIDERATIONS ON THE USE OF BHC

In order to complete this study, we would like to make certain observations noted during our experiments concerning the influence of environmental conditions in relation to the control measures suggested.

INFLUENCE OF DATE OF APPLICATION

This factor is of great importance in not only influencing the degree of the control obtained but also the speed of the result. The sensitiveness of chafer larvae to BHC seems to be definitely a function of their physiological condition. It is for this reason that early spring applications have always, in our opinion, given the best results. At this season, the larvae come to the surface in preparation for attacking plant roots. Emerging thus from hibernation, it is logical that they are constitutionally weak and of low resistance. This hypothesis has been confirmed on many occasions. After having fed for several weeks, the larvae become relatively resistant to even high doses of BHC. The results obtained were clearly unsatisfactory in fertile soils, which demonstrates the influence of a beneficial environment. These findings lead us to suppose that summer treatments in rich soil, in which larvae are likely to be well fed, cannot be justified. Under these conditions, the larvae can exist for a long time in the presence of BHC and even resist it completely. It can be said that under favourable conditions, larvae affected by the normal dose of BHC can live four or five months or more. On the other hand, similar applications on poor, uncropped earth have always given us definite results, although the effect is achieved more slowly in summer than in spring. This deficiency in the effect of BHC under certain conditions has necessitated the study of the rates of application of the insecticide. Increasing these rates has generally increased the speed of larval destruction.

INFLUENCE OF SOIL TEXTURE

We do not attribute great importance to this factor provided that the BHC is well distributed and mixed with the soil so as to come in contact with the larvae. However, the incorporation of the product in the soil can be influenced by the texture as being the governing factor in the degree of contact with the larvae. We have noted that, contrary to other soil insects, wireworms are very susceptible to the fumigant action of BHC. Chafer larvae, however, resist this extremely well.

THE PHYTOXICITY OF BHC ON PLANTS ATTACKED BY CHAFER LARVAE

It has been established and is well known that applications of BHC at high doses can have a considerably harmful effect on plant growth. This has been the case in the series of experiments that we have carried out during the last three years in fruit plantations and nurseries heavily attacked by chafer larvae. Trees weakened by larval attack have shown much greater phytocidal effect from BHC when applications have been made by Pal Injector. We have noted this damage at different times of treatment, and at first sight it does not seem to vary with the stage of development or vegetative vigour. This phenomenon has caused us to add a soluble nitrogenous fertilizer to the BHC liquid injected into the soil in order to stimulate growth

and to reduce the shock to growth following larval attack, thus reducing the phytocidal effect of BHC on the plants. The dose of nitrogenous fertilizer needs to be studied with great care as its addition to the insecticide will necessarily tend to destroy the balance of the sap concentration in the roots, which would be affected by alteration in osmotic pressures. This problem, therefore, restricts the use of strong doses of BHC to unplanted land. In pastures, orchards, forests and ornamental plantations, the control of chafer larvae should not be undertaken until after a careful examination of the various factors involved. In fact, in these situations, the plants are often severely attacked before showing any apparent signs. This is particularly the case in summer. The determination of the application rates of BHC on the one hand and the time of treatment on the other can only be decided after consideration of our results. Summer treatment will require strong doses of BHC even though the weakened growth is likely to show some phytocidal damage. These two problems are extremely complex and demand examination by a specialist in order to arrive at a programme suitable for each particular purpose. The phytotoxicity of BHC has been noted in France on certain varieties of apples and plums and in Belgium on conifers. We have also noted it on pears grafted on quince. The damage, however, is not particularly important.

CONCLUSIONS

From the above, we are able to draw certain conclusions though these must not be regarded as final.

1. Preventive control of chafer larvae can be easily and effectively carried out by the use of BHC dusts applied to the soil.
2. Curative control in annual crops is effective if BHC is mixed with the soil so that it comes in direct contact with the larvae. This method is facilitated on uncropped land.
3. In growing crops, effective treatment can be carried out by watering or by injection, but dusts are never used. These treatments should always be accompanied by a cultivation of the soil.
4. Early spring, which is the season when the larvae emerge from hibernation, has been found to be the best time for the application of insecticides.
5. Higher dosage rates are necessary to destroy chafer larvae than would be the case for other soil insects. These doses, however, should not exceed the limit of tolerance of the plants, which, at the time of treatment, may be weakened by the attacks of the larvae.

APPLICATION OF 'PERENOX' FOR CONTROL OF BLIGHT DISEASES OF POTATO IN WEST BENGAL, INDIA

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INTRODUCTION

POTATOES are grown in the plains of West Bengal (India) from November to March and in its subtemperate and temperate tracts in the Himalayan region from February to June. Potatoes grown in the plains are, generally, susceptible to the early blight (caused by *Alternaria solani* (E & M.) Jones and Grout) while those grown in the Himalayan region are affected by late blight (caused by *Phytophthora infestans* (Mont.) de Bary). West Bengal is, therefore, confronted with the problem of arming herself with the necessary knowledge and equipment for combating both the blights to which the crop is susceptible.

EARLY BLIGHT

Incidence

The early blight appears annually from mid-January and causes spots to develop on the foliage, which finally withers. The comparatively high diurnal temperature (75°—85°F) with a long foggy period in the early hours of the morning creates conditions favourable for the attack. Once started under favourable conditions the disease spreads rapidly and may affect the entire field within 7 days of its first appearance, causing serious damage within a fortnight. The late crop is more vulnerable than the early one, and as the former covers a much larger area and is mainly used for building up stocks, the damage caused by the blight is a very serious problem, both to the grower and to the consumer. The damage has been estimated at about 10% in years of epiphytotics.

Spraying as a Control Measure

The remedy lies in a regular protective fungicidal spraying of the crop before it is actually affected. It becomes impossible to control the disease without timely application of this measure. None of the varieties grown in this State are blight-resistant and the degree of vulnerability is so high that a careful choice of the fungicide which is likely to prove most effective has to be made after judicious experi-

ments and trials. Various trials have been undertaken before with different fungicides, but the results have not yet been systematically recorded as definite findings on the subject. It is, therefore, necessary to collect all available information derived from actual experiments and trials recently carried out in the plains of West Bengal, and to record them for the benefit of the grower and plant protection organisations engaged in this particular work.

The Merits of 'Perenox'

It is not enough for a fungicide to be effective and tenacious ; it has to be cheap and made available to the cultivators in a form which will make its application both easy and effective if it is to be really useful. 'Perenox' has been found, as a result of experiments carried out under field conditions in the plains of West Bengal, to fulfil all these conditions and to prove itself the best among the various fungicides in use. Bordeaux Mixture has hitherto been recommended for control of blight disease of potato. But its primary defect lies in troublesome preparation and application. The secondary defect is its bulk ; the total quantity of constituent chemicals is 4 to 5 times heavier than the quantity of 'Perenox' required to cover the same area, and involves, therefore, considerably higher transport charges. In spite of the fact that Bordeaux Mixture is an effective fungicide for the purpose, it cannot be recommended for general use in this country, where the grower is poor and has to be trained in the use of a fungicide.

The chief points of merit of 'Perenox' are (1) its easy preparation, (2) superior fungicidal value, (3) greater margin of safety. Wide fluctuations of doses cause little damage to the plants. Marsh, Martin and Munsen (1937, *Annals of Applied Biology* XXIV, pp. 853-866) have shown that cuprous oxide (the constituent of 'Perenox') possesses superior fungicidal value in comparison with Bordeaux Mixture. This has been proved by comparative experiments conducted under field conditions in West Bengal. Proprietary fungicides like 'Perenox' are admittedly inferior to Bordeaux Mixture as regards tenacity. But this is more than counterbalanced by its performance in other respects, while this particular inferiority may be eliminated by use of a suitable sticker. Having regard to the conditions in the plains of West Bengal, where the climate is dry in winter and there are few rains, there is less chance of removal of fungicide from the leaf surface, and there is therefore no point in using a sticker at all. The new organic fungicides, Dithane-D-14-Zinc-Sulphate and Lime, Dithane-Z-78 (Zinc ethylene bisdithio-carbamate), which have been found to be superior to copper fungicides in America for control of blight in cooler and moister areas, were also tried along with 'Perenox'. They were not found to be as effective as 'Perenox' under the conditions prevailing in West Bengal, particularly in matters of increased yield. Their performance in West Bengal have not been consistent. Under alternating hot and dry conditions prevalent in the plains of West Bengal, these fungicides show tendencies towards phytocidal damage in the shape of leaf scorching.

Dosages Required

The dosage of 'Perenox' usually recommended for protection against blight of potato is $3\frac{1}{2}$ — $5\frac{1}{2}$ lb. per 100 gallons of water. From experience based on field conditions it has been found that one spray at a dose of $2\frac{1}{2}$ —3 lb. per 100 gallons of water when the plants are young (8"—10" inches in height), and a second one at 4 — $4\frac{1}{2}$ lb. after 3—4 weeks, are quite effective in controlling early blight in the plains of West Bengal. Occasionally a third spray may be needed when the attack is particularly severe. It has also been observed that plants are tolerant to high doses of 5 — $5\frac{1}{2}$ lb. if the plants are full grown, and only one spray or, at the most, two sprays are given. Under such circumstances no phytocidal damage has been reported. A number of sprays, 3 or more, particularly with higher doses of 'Perenox,' has a stunting effect on the plants and may reduce yield. It is quite possible that this reaction is caused, not by the chemical action of higher doses of 'Perenox,' but by a thick deposit of the fungicide on the foliage interfering with photosynthesis. This presumption is strengthened by the fact that overspraying even with lower doses has, in many cases, been found to stunt the growth of the plants.

One conclusion may, in these circumstances, be safely arrived at. Overspraying both with high and low doses should be discouraged for reasons of safety. This is not in accordance with the opinion held by a section of workers, who recommend more frequent spraying with lower doses rather than restricting the number of applications to 2 with recommended doses, except in case of a particularly severe attack, when a third spray may be necessary. Success of the spraying must, in the final analysis, be determined by increase in yield, and it has been found from trials that spraying with higher doses, or frequent spraying with lower doses, has the effect of diminishing the yield rather than increasing it.

Misconceptions Regarding 'Perenox'

There is an idea that spraying with 'Perenox' under a blazing sun, round about midday under conditions prevailing in West Bengal, may cause permanent damage to the plants. Our experience appears to show that this belief is not supported by facts. Spraying in midday may cause, in some cases, a very temporary wilting, but the plants have invariably been found to recover soon after and behave normally.

There is a popular misconception which has to be corrected in connection with 'Perenox.' Some growers are in the habit of asserting that the reaction of the plants immediately after an application of 'Perenox' is seemingly unfavourable, while their reaction after an application of Bordeaux Mixture is supposed to be visibly encouraging. This difference is due obviously to the different colours of the two fungicides. Bordeaux Mixture is refreshingly blue, and it naturally causes the leaves to glitter immediately after use, while 'Perenox', with its dull yellow colour, appears to affect the plants adversely to a

casual and superficial observer. The growers admit, however, that the foliage recovers quickly after a spray with 'Perenox', generally in the course of 2—3 days, and become healthier than before. It may, therefore, be safely concluded that the popular misconception about the immediate effect of 'Perenox' is groundless.

Increase of Longevity and Yield of Sprayed Plants

One major advantage of spraying with copper fungicides, particularly 'Perenox', is the increase in longevity of sprayed plants as compared with unsprayed ones. The day temperature goes up (more than 85°F) in the plains of West Bengal from the end of February, the wind blows high and the foliage begins to wither. The thin deposit of copper fungicide sticks to the leaves and neutralises to a considerable extent the unfavourable effect of solar rays in hot climates. Spraying with 'Perenox' and other copper fungicides has increased the longevity of plants by three weeks, or even more, both under experimental and field conditions. This beneficial quality of the fungicides compensates the grower for the expenditure he may incur from their use, even in cases where there may be grounds for the presumption that the attack is a very mild one. Increased longevity enables the plant to produce a higher yield.

The increase in yield obtained as a result of use of 'Perenox' has been found to be at least as high as 10% or more both under experimental and field conditions. If it were therefore possible to spray the entire area covered by the crop, the damage now caused by early blight might be completely eliminated.

LATE BLIGHT

Incidence

It has already been stated that late blight occurs only in the Himalayan region. The climatic conditions create exceptional difficulties. During the period from April to June the relative humidity in the region is very high (more than 90%) and temperature is low (maximum temperature 60—66°F and minimum temperature 50—55°F). There are prolonged periods of fog with occasional showers. The result is that the disease spreads with alarming rapidity and not infrequently causes complete destruction of the crop, which is the main cause of the exceptionally low yield in this region.

Control

In choosing a proper fungicide to control late blight under climatic conditions prevalent in the Himalayan region, two important points have always to be taken into consideration along with the other qualities of the fungicide, namely (1) high tenacity, (2) low phytocidal damage. As already stated 'Perenox' and other proprietary copper fungicides have a comparatively low tenacity. For this reason frequent spraying with 'Perenox' (6—7 or more at 7—10 days' interval) are required, as the spray residue is washed away by fog and rains. With

regard to damage due to stomatal absorption of copper fungicides in poor light and high humid conditions, 'Perenox' has not been found to be particularly phytotoxic to the potato plants. It has been used, under field conditions, and been found effective for control of late blight in spite of these adverse conditions. It does not seem proper to recommend Bordeaux Mixture for late blight in the Himalayan region, for which it may seem very suitable on account of its higher tenacity, mainly because there is a definite risk of phytocidal damage due to greater chances of absorption of the spray chemicals in poor light and humid conditions. Apart, therefore, from the question of difficulties in its preparation and application, which have been acknowledged everywhere, the risk of greater damage to the crop is a strong argument against its use in the hills. Use of different organic fungicides recently evolved, or of a comparatively low dose of 'Perenox' with a suitable and cheap sticker, is, in these circumstances, indicated. It will perhaps be possible to express a more definite opinion after the results of the experiment now in progress are available.





Fig. 3.—Potato plot sprayed with 'Perenox'

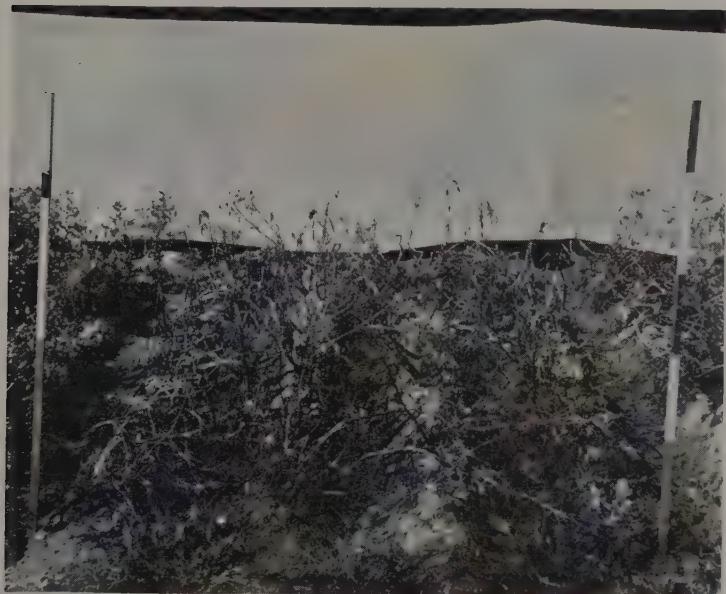


*Fig. 4.—Potato plot unsprayed and severely damaged by
late blight*



Fig. 5.—Devastation caused by early blight of potatoes in India

RECENT ADVANCES IN SUGAR-CANE CULTURE IN QUEENSLAND

By L. G. VALLANCE

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Portion of an article in "The Empire Journal of Experimental Agriculture" Vol. XIX, No. 73, Jan. 1951, reproduced by kind permission of the Publishers, the Director of the Sugar Experiment Stations, Brisbane, and the Author.

A further contribution to our series of articles dealing specifically with the problems of chemical control in relation to sugar-cane.

INTRODUCTION

Climate

THE Queensland sugar industry is concentrated in four main areas within a narrow coastal belt and extends approximately from 16° to 28° south latitude. There is rather a wide variation in climatic conditions over this 1,000 mile strip of country, particularly with regard to temperature. All areas are influenced by late-summer monsoonal rains, the annual precipitation ranging from 40 in. in the south to 180 in. in the wet northern areas. The incidence of low rainfall in the spring and late winter is particularly favourable for harvesting operations and is also conducive to the ripening of the cane during this important period. The data from three districts in the very wet zone (1) have shown that a significant negative correlation (P equals 0.05) exists between the rain falling in the early part of the harvest season (June—August) and the sugar-content of the cane. The regression coefficients indicate that the decrease in C.C.S. (commercial cane sugar) is of the order 0.05, 0.11, and 0.09 units per inch of rainfall respectively in the three mill areas examined. Although serious droughts do occur, in most seasons the rainfall is sufficiently reliable and the bulk of the cane is grown under non-irrigated conditions; a contributing factor to the reluctance to install irrigation facilities is the widespread use of hardy canes which, although containing a proportion of wild blood, have good sugar qualities. An exception is in the Burdekin Delta where some 900,000 tons of cane are grown annually under irrigation. Water is readily available in this area from shallow underground supplies, and the increased returns are reflected in the yield figures, *e.g.* in 1948 the yield per acre amounted to 5.14 t. of sugar as compared with 3.01 t. for the whole of Queensland.

Labour

An interesting fact is that although only about one-fifth of the cane is grown south of the Tropic of Capricorn all farm labour including that of cane-cutting is performed by workers of British or European descent. A further dissimilarity between Queensland and most other sugar industries is the individual ownership of relatively small farms, as compared with the large company-owned plantation system. Some 7,500 growers are engaged and the average area harvested is approximately 35 acres per farm.

Implements

These farms are highly mechanized and most farm operations are carried out by tractor-drawn equipment. Cane harvesters and loaders are relatively little used, one of the main factors precluding the use of such machinery being its high capital cost in relation to individual farm output. However, of late years several small but efficient harvesters have been devised and it seems likely that the use of these will increase considerably in the future. Of particular interest is a shearblade type of cutter which may be drawn by a light tractor. These machines merely sever the cane at the base and cause it to fall at right angles to the row where it is subsequently topped by hand. The latter operation is readily carried out manually, whereas it is particularly difficult to do it satisfactorily by mechanical means.

The use of the planting-machine is now normal practice in all areas. The type known as the cutter-planter is an efficient and labour-saving device. On land which has been prepared for planting, this machine will open the furrow, place the sett in the desired position, and finally cover it over with soil after applying the required fertilizer. The machine is fitted with a cutting mechanism that cuts the cane-stalk into three-bud seed pieces as it is fed into the delivery chute. An added advantage of the use of these planters is that the furrow is opened and the sett placed and covered in a matter of seconds. Previous methods requiring preliminary drilling-out of the field often resulted in the exposure of the soil in the open furrow for several hours, so that a considerable loss of soil moisture occurred which was reflected in lower germination and strike.

THE USE OF BENZENE HEXACHLORIDE

Control of the 'Greyback' grub

The larvae of various Scarabaeid beetles are capable of damaging the roots of the cane-plant, and that of the 'greyback' cockchafer, *Dermolepida albohirtum* (Waterh.), is particularly destructive in this respect. In certain years it has been responsible for enormous losses; for instance, it has been estimated that in 1946 approximately 105,000 t. of cane were lost in the Tully-Cairns area alone. Records, which have been kept since 1934, indicate that such depredations are not isolated cases and that in most years appreciable losses occur. Areas of highly productive soils have gone out of production because of the absence of effective and economical control measures.

However, recent work that was begun in 1946 by Mungomery (2) and his co-workers has shown that correct application of benzene hexachloride dust will provide sure and effective protection against grub damage on even the most highly infested areas. The use of this insecticide has made rapid strides during the past two years, and from the small amount available in the initial period the demand has been so great that in 1949 some 900 t. were applied to approximately 20,000 acres. The value of the treatment is being spectacularly demonstrated in the crops to be harvested this season (1950) in North Queensland, since there is ample evidence that the tonnages on soils known to be highly susceptible to grub attack are appreciably greater than those areas where the previous history seemed to indicate that the incidence of infestation was sufficiently low not to warrant the application of benzene hexachloride. These differences are revealing unsuspected losses on areas previously considered safe, and it is reasonable to assume that even greater acreages will be treated in future. An interesting point is the possible effect on the noble cane *Badila*. As previously mentioned, one of the reasons for the reduced plantings of this excellent sugar producer was the greater resistance to grub attack of the more vigorously rooting wild-blooded canes. It may well be that the relatively inexpensive control of the grub pest provided by benzene hexachloride will lead to *Badila* regaining pride of place as Queensland's major variety.

Of considerable importance is the fact that an application of benzene hexachloride to the plant-crop will also confer immunity upon the subsequent first and second ratoons. There is evidently a quantitative relationship between the amount applied and the duration of the period for which the application remains sufficiently toxic, since a dressing of 150 lb. per acre of 10 per cent. dust is required to protect the three crops. Where protection is required for two crops only, an application of 125 lb. per acre has been found to be sufficient, whilst 100 lb. is adequate for one crop. Up to the present the dust normally used contains 10 per cent. benzene hexachloride (1.3 per cent. gamma isomer) in which the diluent is either pyrophyllite or a mixture of pyrophyllite and finely ground rock phosphate. The mixed diluent has been found to be more satisfactory than either of these two materials used singly. In addition the fertilizer value of the phosphate rock is appreciable. Recent tests indicate that a more concentrated dust containing 2.6 per cent. gamma isomer can be satisfactorily handled with a consequent saving in transport costs. Research work (2) has shown the necessity for fairly close adherence to the recommended method as far as placement and time of application are concerned. Owing to the known residual insecticidal effect the possibility of a build-up in the soil to phytotoxic proportions has also been studied in some detail. However, it seems most unlikely that normal field applications will be accompanied by any adverse effects. With the rapid rise to popularity of this insecticide many new types of tractor-drawn distributors have been developed (3), whilst existing

fertilizer distributors have also been satisfactorily modified (4). Some of these units are capable of treating over 20 acres per day.

Frenchi grub control

The two-year cycle Scarabaeid (*Lepidiota frenchi* Blkb.) has proved much more difficult to control with benzene hexachloride than the one-year cycle 'greyback.' Although the larvae of frenchi are also very susceptible to this insecticide, the habit of the grub to descend into the subsoil below plough-depth in order to undergo a resting period before assuming the third stage somewhat complicates the position. The erratic return of the third-stage grub (which is the destructive stage) to the root-zone together with patchy infestation has made the task of defining economic rates of application difficult. The habits of both beetle and larvae have been studied in detail, and it is well known that when infestation occurs in one crop the damage occurs when the grub in the third stage moves upward from the subsoil to attack the roots of the subsequent crop. In a recent experiment infestation was observed in the plant-crop, and the succeeding first ratoon was completely protected by an application of 150 lb. of benzene hexachloride per acre. Damage was so great in the untreated control plots that practically no harvestable cane was present. In some cases frenchi infestation occurs in the first ratoon with resultant damage to the second ratoon crop. It appears that further experimental work is necessary to define an economic procedure for the control of this grub. Fortunately, although it may cause appreciable losses in certain areas, this pest is of much less importance than *D. albobirtum*.

Wireworm control

For many years wireworms (*Lacon variabilis* Cand.) have caused appreciable damage in the lower-lying areas of the Mackay and Proserpine districts. The destruction of many of the buds of newly planted cane-setts often necessitated the planting of infested areas several times before a satisfactory germination rate was obtained. Costly drainage measures were necessary to reduce the incidence of the pest, and whilst the provision of good drainage is desirable agriculturally, the requirement in respect of wireworm control was frequently much greater than was necessary to produce satisfactory cane crops. Preliminary experiments indicated the potential value of benzene hexachloride and a commercial control of *L. variabilis* was quickly evolved. At the present time little or no loss occurs on even the most susceptible wireworm country. Complete protection is afforded by an application of 20 lb. of benzene hexachloride (1.3 per cent. gamma isomer) per acre. This may be conveniently mixed with the fertilizer normally applied in the drill at planting, and such mixtures are in commercial supply. Some adjustment to the chutes of the fertilizer distributor is necessary since damage to young roots has been recorded where benzene hexachloride has come into direct contact with the germinating sett. This, however, may be readily avoided by suitable placement of the insecticide.

DISEASE CONTROL

As an inheritance from its policy of importing new varieties from many overseas countries in the early stages of its history before the existence of adequate quarantine facilities, Queensland acquired almost every sugar-cane disease of economic importance. Several of these, such as Fiji disease, Gumming disease (*Bacterium vasculorum* (Cobb) Grieg-Smith), and Downy Mildew (*Sclerospora sacchari* T. Miy), are capable of causing enormous losses, and in the past very serious outbreaks have occurred. Other diseases such as Leaf Scald (*Xanthomonas albilineans* Ashby), Mosaic, Red Rot (*Physalospora tucumanensis*), and Chlorotic Streak are of importance. However, notwithstanding the potential threat of these many diseases, the direct losses caused by them of recent years are not great. Such a satisfactory state of affairs is directly attributable to the seriousness with which the industry regards the position, and its insistence on the strict imposition of legislative measures designed to control plantings and in certain cases immediately to destroy any diseased canes. These measures are implemented under the Sugar Experiment Stations Acts, 1900 to 1948, which provide the authority for prohibiting the planting of any variety not gazetted as an 'approved variety.' By this means the planting of resistant or tolerant varieties can be enforced in disease-infested areas. Of course, it is not always possible to substitute non- or less-susceptible canes which have equally desirable yield and agricultural characteristics. Therefore a system of extensive roguing is often necessary to remove potential sources of the spread of the disease. Such work is carried out by the field inspectors of the various Cane Pest and Disease Control Boards which have been established throughout the sugar districts. Some 21 Boards are in existence, the powers of which are derived from the above-mentioned Acts. In addition the State has been divided into ten permanent quarantine districts and the removal of cane from one to the other is prohibited unless by special permit; this also applies to subsidiary quarantine areas which may be imposed from time to time to further localize any disease outbreak. There is no doubt that this control of disease based on legislature has produced excellent results.

Possibly the only disease that has been controlled by fungicidal or other direct treatment is 'pineapple' disease (*Ceratostomella paradoxa*). Some areas, particularly in late autumn or winter plantings, suffer from poor germination due to the invasion of the planted sett by this fungus. In cold soils that are sufficiently moist, the inroad of the organism through the cut ends of the seed-piece is more rapid than the retarded germination of the bud. The result is that the bud fails to develop and a very poor strike is obtained, necessitating a considerable amount of replanting. Experimental work indicated that complete protection could be afforded to the sett by using organic mercurial compounds. This was rapidly followed by commercial application, and many efficient and economic dipping units are in use, some of

which will dip a ton of cane in one operation. The solution used contains 0.015 per cent. mercury, and a half-minute dip will suffice (5). A practical difficulty that has occurred is in connection with the use of the cutter-planter. Since this very popular planting-machine cuts the stalk into setts prior to placing the seed-cane in the furrow, it is not possible to dip the setts before planting with such equipment. Therefore the grower has had to revert to the older type of drop planter in which the setts are cut beforehand.

ACKNOWLEDGEMENTS

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- (5) Hughes, C. G., Bur. Sug. Expt. Stat., Queensland, Farm Bull. No. 11, p. 9.

22

THE THREAT TO WEST AFRICAN COCOA

INTRODUCTION

OUR attention has again been drawn to the swollen shoot disease of cacao—probably the biggest plant disease problem in the world today—by the recent announcements in *The Observer* (1), the *Daily Express* (2) and the *Times* (3) that control measures involving cutting out of diseased cacao trees have been suspended by the Gold Coast Government, and that a new systemic insecticide has been developed to control the insect vectors. This treatment is still in the experimental stage, and there is as yet no certainty that it will become a practical means of control. There is no doubt that the destruction of diseased trees (to reduce the spread of the virus) has been unpopular with the farmers, despite the compensation paid, and the rise in the price of cacao has heightened their dislike by increasing the value of the crop they can reap before the trees die of disease. At the Cocoa Conference held in September, 1950, the Deputy Director of Agriculture, Gold Coast (4), pointed out that although the work of cutting out was proceeding fairly smoothly, many farmers would not consent, were there no compulsion.

PROBLEM OF DISEASE CONTROL

It appears now that it is the very size of the problem which makes control so difficult to achieve in the country as a whole. At the same Cocoa Conference, the Director of the West African Cacao Research Institute pointed out (5) that the higher the incidence of the disease the less effective is cutting out as a control measure, probably because of the greater number of infected trees which have not yet shown symptoms at the time of treatment, and because only visibly affected trees are cut out. When more than 30% of the trees are infected, it may be better to treat and replant a whole block—the size of the block would vary according to conditions—rather than try to treat it piecemeal.

RESEARCH ON THE DISEASE

The Viruses and Their Transmission

To judge from the Annual Reports of the West African Cacao Research Institute and from the series of papers (apparently not yet concluded) published in the *Annals of Applied Biology* since 1947 under the authorship of A. F. Posnette and his collaborators S. H. Crowdy, D. W. Goodall, N. F. Robertson, A. H. Strickland and J. McA. Todd, there are few aspects of the disease which have not

been studied intensively. It is significant that, whereas in his 1947 paper (6) Posnette described four virus diseases transmitted by three species of mealybugs, in his most recent paper (7) he lists seventeen viruses and eleven vector species.

In the second paper (8) Crowdy and Posnette described the effect of three viruses on yield. When mature trees were infected with the prevalent virus, the number of pods was reduced by 25% in the first crop after infection, 50% in the second and there was practically no third crop, as most of the trees were then dead. A mild but comparatively rare virus caused no appreciable loss of crop, but a virus intermediate in virulence caused a 50% decline in three years. Actual losses were higher than these figures suggest because pod size was also reduced.

Goodall (9) found that virus infection caused, among other effects, the death of fine roots, and that the lateral roots of infected plants were proportionately smaller than those of healthy ones. This may account, at least partly, for the rapid decline and death of infected trees in a manner suggesting drought die-back.

The third paper (10) described the development of a satisfactory method for the insect transmission of the viruses, an original feature being the use of cacao beans. By feeding the virus-carrying mealybugs on beans, Posnette and Strickland obtained more rapid and uniform transmission than by using seedlings, and the economy in space enabled far larger numbers of plants to be used in later vector experiments. Following this, Posnette and Robertson (11) studied the feeding times required by the mealybugs to transmit virus, and found that although some 10 hours' feeding on an infected plant was required for the insects to reach maximum infectivity, only 20 minutes' feeding on a healthy plant was sufficient to transmit the virus; there was no increase in the number of plants infected with feeding times longer than 50 minutes. When infective mealybugs were starved, they remained fully infective for 12 hours, after which they gradually lost the ability to transmit virus until, after 36 hours, no transmission at all occurred. This explains the success of cutting down the infected trees in stopping the spread, since mealybugs are slow-moving insects and although they can readily walk from tree to tree in the interlacing canopy of a cacao farm, few are likely to find their way over the ground from a felled to a standing tree within 36 hours. As a routine measure, the felled trees are moved several yards at least from the nearest healthy tree.

Wild Host Plants

Probably the most important paper, as regards long-term control of the disease, is that by Posnette, Robertson and Todd (12) on the wild host plants of the viruses. They found that several species of forest trees can carry the virus and act as reservoirs of infection. These trees suffer very little ill-effect, so that infected trees cannot be distinguished from healthy ones with certainty, unless tests are

carried out by feeding mealybugs on their stems or leaves, and then transferring the mealybugs to healthy cacao seedlings. The virus is easily transmitted in this way from *Cola chlamydantha* and *Adansonia digitata* to cacao, but is more difficult to transmit from the silk cotton trees, *Ceiba* and *Bombax*, and from *Cola cordifolia*, probably because these plants contain a lower concentration of virus in their sap. This agrees with observations in the field; where *C. chlamydantha* occurs (only in certain areas in the western part of the Gold Coast) scattered outbreaks occur in the cacao near to infected *C. chlamydantha* trees, which have also been found in forest reserves several miles from cacao. Where large areas of cacao have been devastated by swollen shoot, silk cotton trees and *C. cordifolia* trees are common and are foci of infection, but the rapid mass spread of the virus from cacao to cacao has now obliterated most of the original small scattered outbreaks which probably started from wild host plants.

RESEARCH ON SUBSIDIARY CONTROL MEASURES

Until this mass of infection in cacao is destroyed by the cutting-out campaign, it seems unlikely that subsidiary control measures can have much effect. Recent reports show, however, that research is progressing along three main lines—the control of the mealybug vector, the eradication of wild host plants of the virus and the development of resistant types of cacao for replanting.

Control of the mealybug is complicated by ants. Strickland (13) found that about 75% of mealybug colonies on cacao are covered by mud or carton tents constructed by certain types of ants to protect the mealybugs from rain and enemies, and this makes chemical control extremely difficult when combined with such factors as lack of plentiful water supplies, few roads among the farms, uneven ground and irregularly spaced trees. Until recently, therefore, the only promising line of attack on the mealybug appeared to be biological. Insect parasites have been introduced (14) to supplement the indigenous enemies, and some success has also been obtained with a fungal parasite (15). Now, however, the discovery of a systemic insecticide which can be applied to the roots opens a new line of attack.

The eradication of infected wild plants near to cacao seems likely to prove a difficult task, because they grow into such large trees. Unless suitable poisons can be found among the newer herbicides, it may be possible to destroy only young trees and seedlings, leaving old trees to die. It may soothe the foresters and shade lovers if we point out that few species, none of them timber trees, are implicated.

If a type of cacao resistant to virus infection could be found, replanting could proceed in the devastated areas with more assurance of success than at present. That considerable progress has been made in this line of research is obvious from the annual reports, and we expect to see a full paper on the subject before long. The selection and propagation of surviving trees in devastated farms resulted only

in "immunised plants" which were infected with mild virus strains. No immune types were found, and so a large collection of varieties new to West Africa was introduced from the West Indies and South America. Among these new kinds there may be one, perhaps more, which is resistant to the virus, and if so, a great advance will be made. We must remember, however, that no quantity of resistant plants will help to control the spread of virus among the existing healthy cacao trees, and how to save these is the immediate problem.

EXTENT AND SPREAD OF INFECTION

Until the detailed survey is complete, an accurate estimate of the extent of infection and the number of infected trees is impossible. There is no doubt that millions of trees are involved. In 1948 the Gold Coast Department of Agriculture (16) estimated the number of infected trees to be 46 million, increasing at approximately 10 million a year. The annual rate of infection will depend on so many factors that predictions are dangerous. The rate of spread in observed outbreaks has increased with the size of the outbreak, provided there was unlimited healthy cacao into which the disease could spread. In the Gold Coast there are natural forest barriers which might be expected to retard the mass spread of the disease from the Eastern Province to Ashanti, for example. Once the infection has passed these barriers and mass spread can proceed in the heavily planted areas in Ashanti, the annual loss of trees may well increase geometrically. The future of cacao in Ashanti depends to a great extent on the success of the campaign now being waged in the Eastern Province. In fact, unless some curative treatment for virus diseases can be found, the whole future of cacao in West Africa must depend on the willingness of the farmers to destroy, or allow to be destroyed, infected trees, so that the virus cannot spread from them to healthy trees which may be owned by someone else. Such co-operative thinking has not, in the past, been a feature of agriculture in West Africa.

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TECHNICAL BREVITIES

This section includes information on plant protection problems in their widest sense, which has been obtained from published literature. We have given the references to the publications concerned.

INSECTICIDES

AS a result of laboratory tests and field experiments it is concluded that BHC is promising for the control of coffee berry borer in Brazil, and more effective than DDT. The material used in the experiments were dusts of crude BHC to give 2 per cent. gamma isomer, 5 per cent DDT or a mixture of both.

Seixas, C.A., "Contrôle químico da broca de café" (Chemical control of the Coffee Berry Borer") *Biológico*, 13, No. 12, pp. 215-228, São Paulo, 1947.

Abstd. in Rev. App. Ent. (Series A), Vol. 39, part 1, Jan. 1951, pp. 26-27.

POISON BAIT FOR CRICKETS

Although sawdust has been recommended in the past as a substitute for bran in making poison baits for crickets, subsequent experience has shown that this material gives satisfactory results only where pastures are thin or where a field is under cultivation. Where there is a good pasture sward it is necessary to use bran or equal parts of bran and sawdust to tempt the crickets. Bran or fowl mash also remains effective for 3 or 4 weeks, while sawdust bait becomes valueless as soon as it has dried out.

N.Z. Jour. of Agric. Vol. 82, No. 1, Jan. 15, 1951, p. 46.

PLANT PROTECTION SUPPLEMENTING BIOLOGICAL CONTROL

In the control of the West Indian peach scale, *Pseudaulacaspis pentagona* (Targioni) by ladybeetles, *Chilocorus bivulneris* Mulsant, it was found at Kenscoff, Haiti, that ladybeetles feeding on scale insects on peach trees were uninterrupted in their activities, and in fact were so successful, from the standpoint of the grower, that they entirely eliminated their food supply. The next generation was forced to migrate or perish of starvation in the Kenscoff region, well illustrating

the fundamental fallacy in biological control that when it is really successful it is so completely so that the predator is eliminated. With the aid of man, commercial control of incipient outbreaks of peach scale might now become absolute local eradication. Without such interference the only factor likely to prevent scale infestation recurrence is the aggressive migratory urge of the ladybeetle which still exists at lower elevations.

Commercial control followed by almost complete eradication of sugar cane white grubs and other insect foods of the introduced giant toad, *Bufo marinus*, in the cane fields of Puerto Rico, by eliminating the main food supply of the toads and through an increase in abundance of the toads' enemies, made the survival of any large number of them impossible. The result was a rapid increase in numbers of insects upon which the toads fed—insects which had come so near extinction a few years before. Outbreaks of sugar cane white grubs also became numerous but nowadays several effective chemicals, such as BHC and 'Hyman' 118 are available to control them. The former is now used on a large scale against the grubs, tests having indicated that 2 lb. of the gamma isomer per acre will effect commercial control. Its residual effect is apparently greater than that of the equally effective 'Hyman' 118, and its extensive use points to the increasing preference of growers for the use of chemicals than reliance on the comparatively uncertain and undependable biological means of control.

Puerto Rican mole cricket or "changa" (*Scapteriscus vicinus* Scudder) had its numbers reduced by *Bufo marinus*. But when conditions of sub-normal rainfall and the upset of nature's balance made it difficult for the toad to survive, "changa" population increased. Synthesis of new insecticides, DDT, chlordan and 'Hyman' 118 made control possible, especially if their application was promptly followed by rain, making "changas" come to the surface.

The author states that it is indeed most fortunate that really effective chemical insecticides are now available for the control of so many insects to supplement the deficiencies and uncertainties of biological means when they fail to function. The most apparent fundamental weakness of biological control is its dependence on a single predator or parasite.

"*Pests and Diseases and Plant Protection Supplementing Biological Control*," by George N. Wolcott. *Trop. Agric.* Vol. 27, Nos. 1-3, Jan.-Mar., 1950, pp. 28-35.

MEADOW SPITTLEBUG CONTROL

In Ohio good control of the meadow spittlebug, *Philaenus leucophthalmus*, with up to 44% increases in red clover yield was given by spraying gamma-BHC at 2 to 3.2 oz. per acre. Emulsions were more practical than wettable powders in low pressure sprayers. High concentrations of parathion and EPN (ethyl p-nitro-phenylthionobenzene phosphonate) gave very poor kills in tests.

Weaver, C.R., *J. Econ. Ent.*, 1950, 43 (1): 7-11.

MANGO HOPPER CONTROL

In the Punjab, India, mango hopper, *Idiocerus* sp., which causes great reduction in the mango crop by sucking sap from and de-vitalizing the floral shoots, was efficiently controlled on trees 40 to 50 feet high by a single power spraying of the inflorescence with 0.15% DDT. The residual effect lasted 5 weeks.

Sodhi, G. S., and Batra, A. L., *Indian Fmg.*, 1950, 11 (4) : 158-61.

MEDITERRANEAN FRUIT FLY CONTROL

Results of cage and field trials in Western Australia against the Mediterranean fruit fly, *Ceratitis capitata*, a serious orchard pest, using gamma-BHC, sodium fluosilicate and p.p.' DDT, indicate that BHC has several very promising applications in fruit fly control, but more field work is needed before recommendations can be made.

Ryan, F. E., *J. Agric. W. Austr.*, 1950, 27 (2) : 226-38.

ACARICIDE TESTS

In New York State effective kills of winter eggs of European red mite, *Paratetranychus pilosus*, were given by dormant sprays of 2% petroleum oil and by 0.5% of dinitro sec. butyl phenol or dinitro amyl phenol preparations containing 21.5% toxicant as the acid.

In summer applications with several new acaricides compound 3901 (5-mercapto acetyl urea 0,0-dimethyl dithiophosphate) and EPN (31.5% ethyl p-nitrophenyl thionobenzene phosphonate) were as effective as parathion against European red mite and clover mite, *Bryobia praetiosa*, but 3901 was the only material giving high extended protection against two-spotted spider mite, *Tetranychus bimaculatus*.

Chapman, P. J. and Lienk, S. E., *J. Econ. Ent.*, 1950, 43 (3) : 309-14.

PEACH TREE BORER CONTROL

In Georgia effective control of peach tree borer, *Sanninoidea exitiosa*, was obtained by three sprayings of BHC (6% gamma isomer) or DDT (50%) at 8 lb. per 100 gall. applied to the trunks and lower limbs of peach trees during the oviposition period. Results were as good as fumigant-type treatments in which emulsions of propylene dichloride and ethylene dichloride and crystals of paradichlorobenzene were applied to the soil around the tree bases; but hexachloroethane crystals were less effective. Poor control was obtained by single sprayings of BHC and DDT, as dusts or as suspensions poured round the trees, and by BHC dust applied in a band around tree bases.

Snapp, O. I., *J. Econ. Ent.*, 1950, 43 (3) : 315-8.

BENZENE HEXACHLORIDE PRODUCTS ('TIOGAMMA' AND 'TOXIN' C) FOR THE CONTROL OF LOCUSTS (IN ITALIAN).

Experiments on the control of *Calliptamus italicus* L. and *Locusta migratoria* L. were carried out in the province of Catanzano, Southern

Italy, in the autumn of 1946, using BHC in the form of 'Tiogamma,' containing 20% BHC and 3% thiocyanates, and 'Toxin' C, containing 20% BHC.

Baits were first made with bran mixed with 2% of the above mentioned powders and moistened with water. Good results were obtained, in spite of the difficulty experienced in covering all the flakes of bran with 'Tiogamma' with a resulting uneven mortality. To overcome this difficulty, and in view of water scarcity in infested areas, a dust of 4% 'Tiogamma' in talc was tried and proved much superior to the 'Tiogamma' bait. Preliminary tests with sieved earth as a substitute for talc also gave promising results.

Costantino, G., *Circ. Osserv. reg. Fitopat. Calabria*, No. 4. 7 pp. Catanzaro, 1948.

Abstd. in Rev. App. Ent., Vol. 39, Ser. A., No. 3., Mar., 1951, p. 75.

PRACTICAL CONTROL EXPERIMENTS AGAINST THE SAN JOSE SCALE IN SOUTHERN TYROL (IN FRENCH)

Spraying experiments on apple trees 5—7 years old with 139 different insecticides for the control of hibernating scales, followed by a second spraying in August, yielded the following results :—

Dinitrocresol preparations and mixtures of dinitrocresols with carbolineum gave 71% and 92% control.

DDT was ineffective.

Lime-sulphur, 10% up to 30%, gave 80—100% control.

Lime-sulphur with an emulsified carbolineum gave 99% control.

Best results were obtained with emulsions of white oils combined with dinitro cresol.

H. B., *Rev. Hort. Suisse*, 20 (9), 225-227, 1947. (*Abstd. in Biol. Absts.*, 25, 5, May, 1951, *Abst. No.* 15327).

POSSIBILITIES OF CONTROLLING THE HOPLOCAMPA SPP. OR SAW FLIES OF PLUM TREES (IN FRENCH)

Experiments on the control of *Hoplocampa minuta* and *H. flava* were carried out in Switzerland in 1944 and 1946, as a result of which 'Gesarol' gave 71% control, a new DDT preparation of Geigy gave 97% and hexachlorocyclohexane (HCH or BHC) preparation 941 gave 99—100%.

Guenthart, E. and R. Holenstein, *Rev. Hort. Suisse*, 20 (1), 2-5, 1947. (*Abstd. in Biol. Absts.*, 25, 5 May, 1951, *Abst. No.* 15326).

ACQUIRED RESISTANCE OF RED SPIDER TO PARATHION

Resistance of greenhouse red spider to parathion aerosols has been observed in several rose houses in Connecticut. As resistance was lost on transference of the mites to beans, it is thought that some food element may be concerned.

Garman, P., *J. Econ. Ent.*, 1950, 43 (1) : 53-6.

MEALY BUG CONTROL ON TABLE GRAPES

At the Stellenbosch Fruit Research Station, Cape Province, good results have been obtained during the past two seasons in the control of mealy bugs (*Pseudococcus spp.*) attacking grape vines by the judicious application of parathion.

It is recommended that the product should be applied only to selected spots or blocks of vines which are most severely infested. To avoid the extermination of parasites and predators, lightly infested vines should be left untreated. On the untreated vines the pests will be economically controlled by natural means and will thus serve as breeding grounds for parasites and predators, which will later recolonize the chemically treated areas. Severe outbreaks can thus be checked by parathion without unduly upsetting the balance between the pest and its natural enemies. The alternative course with severe infestations is to carry out regular and thorough parathion sprayings throughout the vineyards, a procedure which may be encouraged by the favourable export market for table grapes.

A. C. Myburgh, "Farming in South Africa," Vol. 26, No. 298, Jan., 1951, pp. 14-16.

CONTROL OF THE CITRUS MEALY BUG ON GRAPE VINES BY ORGANIC PHOSPHATE PREPARATIONS

Experiments were carried out in Israel in 1949 on control of the citrus mealy bug (*Pseudococcus citri* Risso) on grape vines with sprays of 0.1 per cent. hexaethyl tetraphosphate, with a spreader, and 0.2 per cent. of a preparation containing 15 per cent. parathion, applied to the vines at the end of July, two months after the mealy bugs appeared on the leaves.

Percentages of infested fruits, 17 days later, were 25 and 14 respectively, as compared with 55 in the control plot, and both compounds seemed harmless to both vines and grapes.

In 1950, 0.15 per cent. of a preparation containing 20% parathion with a spreader was applied on 16th June on the first appearance of the insects on the leaves. Six weeks later infestation of the fruit from the untreated vines was 18 times as great as that on fruit from sprayed vines, the better control as compared with 1949 being attributed to the earlier spraying date in 1950.

Good control of the grape berry moth (*Polychrosis botrana* Schiff) was also obtained by the use of parathion.

Avidov, Z. (formerly Klein, H. Z.,) and Swirsky, E., Hassadeh, 30, No. 12, pp. 716-718. Tel-Aviv, 1950. (*Abstd. in Rev. App. Ent.*, 39, Ser. A., 2, Feb. 1951, p. 63).

FUNGICIDES

THE USE OF SEED DRESSINGS IN THE CONTROL OF FUNGUS DISEASES OF TEA SEED

At the Tea Scientific Department, Madras, it was decided to investigate the possibility of using one of the numerous seed dressings now available to see if the principle of controlling seed-borne diseases on other types of seed could be extended satisfactorily to tea seed.

Dressings chosen—‘Agrosan’ GN and ‘Fernasan.’

‘Agrosan’ GN was applied in dust form and as a liquid.

‘Fernasan’ was applied as a dust.

In dust form both dressings were applied at the rate of 4 oz. per 82 lb. (1 maund) tea seed.

Treatment with ‘Agrosan’ GN as a liquid consisted of incorporating the dressing in the water used for testing for ‘floaters and sinkers’ at the rate of 8 oz. per 10 gall. water. The normal immersion given to the seed was sufficient for an adequate cover of seed dressing.

As the quality of seed used was uniformly high and no cases of fungal infection were noticed in either the treated or untreated seed, the experiment failed to yield information on the control of seed-borne fungi by application of standard seed dressings, but it nevertheless showed that rapidity of germination of treated seed was greater than that of the control, the rate of which was representative of the normal rate of germination of seed in the district.

Inspection of the nurseries two months after receipt of the seed showed that less than 10% of the seed in treated batches had failed to germinate, while little more than 30% of the control batch had been put out into baskets.

Seed treated with ‘Fernasan’ germinated more rapidly than the ‘Agrosan’ GN treated batch, and it also appeared that the rate of elongation of the radicle was to some extent increased.

Seed treated with both ‘Agrosan’ GN and ‘Fernasan’ showed approximately 90% germination within 8 weeks and about 20% of the ‘Fernasan’ treated seed was in baskets in less than 4 weeks.

Peter de Jong, The Planters' Chronicle, XLVI, No. 4, February 15th, 1951, pp. 91-92.

CONTROL OF ONION SMUT (*Urocystis cepulae*)

According to M. B. Linn, of the University of Illinois, the formaldehyde dip treatment as a control for onion smut (*Urocystis cepulae*) has been almost entirely replaced in Cook County, Illinois, by the pelleting of bulb-onion seed with ‘Arasan’ (50% thiram, non-wettable in water) at the standard dosage of one pound of fungicide

to one pound of seed, previously moistened with 5% 'Methocel' (Dow Methyl Cellulose) sticker solution. The shattering or flaking off of the fungicide has been reduced in Illinois experiments by the addition of commercial glycerin, 10% by volume, as a plasticizer, which presumably makes the 'Methocel' film less brittle on drying.

Miller, Paul R., *Agric. Chem.*, May, 1951, p. 59.

COPPER FUNGICIDE PERSISTENCY— EFFECT OF WEATHER

When copper oxychloride dusts and copper oxide sprays were applied in Ceylon to dry tea leaves which were exposed to rain immediately after treatment, a small amount of rain was sufficient to remove the bulk of the fungicide, but an appreciable remainder was held after moderate rainfall, e.g., after 7-in. rainfall 88 p.p.m. copper was left out of a dust deposit of 596 p.p.m., 168 p.p.m. out of a spray deposit (exposed wet) of 1,300 p.p.m. and 200 p.p.m. out of a spray deposit (dried before exposure) of 884 p.p.m. Applied to wet foliage during rain, retention was reasonably good, but in this trial a spell of dry weather intervened and 2.5-in. rain over 2 hours was given artificially. No fungicide was retained on bushes sprayed at the beginning of a deluge of 0.7-in. in 15 min. Large scale trials indicate that the small amounts of copper retained after bad weather are enough to give some protection against blister blight infection. If spraying at the recommended rates is done immediately after plucking, the copper content of the made tea should be less than 100 p.p.m. even under dry conditions, and dusting under south-west monsoon conditions should leave less than 80 p.p.m. if 7 to 8 days elapse before plucking.

Haworth, F., *Tea Quart.*, 1950, 21 (4) : 28-32.

See next abstract.

In Ceylon a temporary tolerance limit of 150 p.p.m. copper in manufactured tea has been allowed for the U.K. market, following the author's recommendation to the Metallic Contamination Sub-Committee of the Food and Labelling Division of the Ministry of Food.

Lamb, J., *Tea Quart.*, 1950, 21 (4) : 33-5.

OLIVE LEAF SPOT CONTROL

Olive leaf spot (*Cycloconium oleaginum*) was satisfactorily controlled in three years trials in Palestine (Israel) by spraying Bordeaux Mixture at 1% (0.25% Cu.) and by 'Perenox' at 1/3% (0.17% Cu.). Correct timing is decisive for success. The best time to spray is when most of the young growth has been made, but before extensive infection has developed. Spring applications were effective, but two applications in summer and autumn gave good results where disease was severe, and only one summer spraying was needed where infection was mild.

Palti, J., et al, *Palestine J. Botany*, R. Ser., 1949, 7 (1-2) : 167-73.

BLISTER BLIGHT CONTROL

Of 58 fungicides in 188 formulations tested in Ceylon against blister blight, *Exobasidium vexans*, copper-based fungicides were superior to the others. A systemic fungicide was promising.

Lamb, J., Tea Quart., 1950, 21 (4) : 4-7.

BLISTER BLIGHT CONTROL : PROTECTION DURING RECOVERY FROM PRUNING

In Ceylon satisfactory and economical protection from blister blight, *Exobasidium vexans*, for tea recovering from pruning during the south-west monsoon is given by spraying 'Perenox' at 4 oz. per 10 galls. using 12 galls. per acre on 7-day rounds. Spraying during rain was very successful. An average of 16 spraying rounds gave protection at a cost of about Rs. 36 per acre.

Portsmouth, G. B., Tea Quart., 1950, 21 (4) : 11-16.

DISINFECTION OF GROUNDNUT SEED (FRENCH EQUAT. AFRICA — FR. WEST AFRICA)

During 1950 parallel tests of various fungicides on the germination and emergence of groundnut seed and duration of efficacy were carried out at Loudima, Middle French Congo and in Senegal.

Best results were given by :—

Two dusts—non-commercial, unknown composition.

Tetramethylthiuram disulphide

Methoxyethyl mercury silicate

Organo-mercury compound and

Methoxyethyl mercury silicate plus gamma isomer of HCH.

The cost of treatment is low compared with the financial return from the crops from treated seed. Seed disinfection before sowing is the first and one of the most effective means of developing groundnut production.

"*Oleagineux*," 6, 1, pp. 1-10, 1951. (*Abstd. in R.A.M.*, 30, 4, *Apl.*, 1951, p. 212.)

GROUND SPRAYS FOR THE CONTROL OF APPLE SCAB

The material most generally used for this purpose in America and South Australia is a salt of dinitro-ortho-cresol, sprayed on the fallen leaves at $\frac{1}{2}$ to 1%, which was found in trials to be effective in reducing the discharge of ascospores in spring.

Harris, W. B., J. Dept. Agric., S. Austr., 1950, 53 : 543. (*Abstd. in Hort. Absts.*, 21 : 1 : *Mar.*, 1951, p. 49).

WEEDKILLERS AND HORMONE PRODUCTS

CHEMICAL WEEDING POSSIBLE FOR DIRECT SEEDED TOMATOES

A commercial preparation containing approximately 10% pentachlorophenol in an aromatic oil was found to be the most promising chemical. 80—90% of the weeds were killed with no accompanying reduction in stand or yield of the tomato crop, the estimated cost of enough material to spray a strip 1-ft. wide over the rows being \$1.00 to \$1.50 per acre.

Warren, G. F., (*Purdue Univ., Lafayette, Ind.*) *Food Packer*, 31 (5): 38-39, 1950. (*Abstd. in Biol. Absts.* 25, 5, May, 1951, *Abst. No.* 15067).

GROWTH REGULATORS TREBLE CACAO YIELDS

According to V. S. Gardner, Chief of the U.S. Agricultural Mission to Colombia, a simple, inexpensive and practicable technique has been developed which will at least treble yields of cacao trees by rejuvenating weak flowering and fruiting cushions through the use of improved hormones. The new technique is the outcome of co-operative experiments by U.S. and Colombian scientists at the Palmira Station in Colombia. No details are given.

"Foreign Crops and Markets," 1951, 62 (4): 87.

HORMONE WEEDKILLERS FOR SCRUB CONTROL

2,4,5-T, which was originally introduced into New Zealand for blackberry control, has since proved more efficient against gorse.

Conclusions which may be drawn from preliminary experiments, and which may need modification after further research, are as follows:—

- (a) A complete cover of all green parts of the gorse plant by the weedkiller is essential.
- (b) High temperatures and fair growing conditions at the time of application of the weedkillers are more important than moderate temperatures with good growing conditions.
- (c) Gorse in its young stage is quite susceptible to 2,4,5-T, but with age becomes increasingly resistant to the weedkiller, which fails to control cut or damaged plants.
- (d) Shoots sprouting from old, cut or burnt root stocks should not be sprayed with 2,4,5-T formulations for 9 to 12 months after cutting or burning.
- (e) Control is more difficult if gorse is flowering profusely.
- (f) It is generally recommended that gorse should not be sprayed under cold atmospheric conditions and when the soil is cold and wet.
- (g) Formulations containing 2,4,5-T alone are more efficient in the control of gorse than preparations containing a mixture of

2,4,5-T and 2,4-D, which are employed to secure effective control of a mixed association of gorse and scotch thistle.

- (h) Gorse can be most profitably treated when it is in the stage up to 3-ft. in height before flowering. Applications of 1 lb. acid equivalent per acre of a volatile formulation of straight 2,4,5-T give the desired control under optimum spraying conditions in the northern districts.

L. J. Matthews, *N.Z. Jour. Agric.*, Vol. 82, No. 1, Jan. 15, 1951, pp. 11-14.

CONTROL OF BUTTERCUP AND PENNYROYAL ON HAURAKI PLAINS

The development of hormone weedkillers and the invention of the low-volume spray nozzle have now made it possible to eliminate the perennial weed pennyroyal from pastures and buttercup from pastures grazed by cattle, for which there were no satisfactory economic methods up to two seasons ago.

Control of these weeds by the use of hormone weedkillers is now the general practice on the Hauraki Plains, where about 2,000 acres of pasture were sprayed last spring (southern hemisphere) for this purpose.

The ethyl ester of 2,4-D (oil based) and the sodium salt of 2,4-D (water soluble) are being successfully used for the control of buttercup and pennyroyal, and MCPA, represented commercially by 'Agroxone,' in addition to the other two chemicals, for the control of buttercup. G. L. Banfield, *N.Z. Jour. Agric.*, Vol. 82, No. 1, Jan. 15, 1951, pp. 69-74.

THE EFFECT OF GROWTH SUBSTANCES ON THE REPRODUCTIVE ORGANS OF FRUIT TREES

Experiments on pear trees showed that 2,4-D at 5 p.p.m. was the best and cheapest growth substance for the control of summer drop of fruit from trees on which many flowers were damaged by spring frost.

Sergeev, L. I., *Doklady Akad. Nauk S.S.S.R.*, 1948, 62 : 545-8. (*Abstd. in Hort. Absts.*, 21, 1, Mar. 1951 : p. 31).

SOME EFFECTS ON FRUIT GROWTH AND QUALITY OF A 2,4-D SPRAY APPLIED TO BEARSS LIME TREES

Preliminary trials in California show that lime trees sprayed with 16 p.p.m. 2,4-D as the isopropyl ester about ten weeks before fruit picking commences produce a greater rate of fruit growth than do untreated trees. No commercial recommendation for the use of 2,4-D for this purpose has yet been made, however.

Louis C. Erickson and B. L. Brannaman, *Proc. Amer. Soc. for Hort. Science*, Vol. 56, Dec., 1950, pp. 79-82.

GENERAL

ONE YEAR'S AGRICULTURAL AVIATION IN ISRAEL

The initiative of Chim-Avir Ltd., a private company in Israel, with the support and under the supervision of the Israel authorities, has resulted in the utilisation in Israel of the experience gained in the United States in the aerial application of agricultural chemicals.

The aerial equipment purchased consisted of three Piper Cub aircraft, two for spraying and one for dusting, and four Stearman biplanes for either spraying or dusting. Actual operations were started in the autumn of 1949, and an unexpected measure of success was achieved by the company in their first year of agricultural flying.

The problems tackled to the satisfaction of farmers included the following :—

1. Weed control spraying of 6,000 acres of winter cereals with 2,4-D (Kathon M-7) and MCPA ('Agroxone' 3) mostly at the rate of 250—350 g. of 2,4-D acid equivalent in 4 gall. of spray per acre. All major weeds on heavy soils were controlled and a species of *Anthemis*, the most dangerous weed on sandy soils, was checked by spraying with 500 g. 2,4-D acid equivalent per acre.
2. Weed control spraying in February on an area of about 1,000 acres of heavy soil in preparation for summer crops, as a result of which the dominant weeds of the charlock and wild carrot type were destroyed in the seedling stage without the necessity of cultivation before sowing the crop.
3. Sulphur dusting of some 2,000 acres under grape vines, at about 30 lb. dust per acre, and almost 5,000 acres under citrus crops, at 30—40 lb. per acre, with excellent results.
4. Dusting tomatoes with a mixture of sulphur and DDT to control powdery mildew (*Oidiopsis taurica*), red spider and the bug, *Cyrtopeltis tenuis*.
5. Various insecticidal dustings with Cryocide, DDT and BHC, which were completed satisfactorily.

The use of aircraft for crop protection is most advantageous where the ground is wet and on tall crops. Very light dust diluents should be avoided.

J. Palti and S. J. Ellern, "World Crops," 3, 3, March, 1951, pp. 104-5.

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